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# STRATIOMYIID LARVÆ AND PUPARIA OF THE NORTH EASTERN STATES.

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For some years, I have collected, as occasion offered, the immature stages of Diptera and in this way have accumulated a number of the larvæ and puparia of the Stratiomyiidae, among which there are three genera, fourteen species in the last instar, and seven species in earlier instars which have not heretofore been described. As it may be of interest to entomologists I am offering here a key to the known early stages of genera and species occurring in the North Eastern States. In view of the number of additional forms included, I believe no apology is needed for publishing a paper on this subject so soon after the appearance of the excellent table included by Mr. Malloch in his work, published in 1917.

That there is secreted by the hypodermis of the larvæ of this family a heavy deposit of calcium carbonate has long been known. This deposit, which forms on all parts of the body, including the appendages of the head, is sometimes so thick and dense that it obscures the outlines of the more delicate parts and renders their study difficult and sometimes impossible. By dropping the insect in dilute hydrochloric acid for a moment, until the active effervescence ceases, the deposit is removed and the integument rendered beautifully clean. Placed in a 10 per cent. solution of caustic potash for 24 hours or until the darker mouth parts become pale, it can then be freed from the dissolved internal tissues, dehydrated, cleared and mounted in

balsam in the usual way. If care is taken to support the cover glass sufficiently the mount will not be distorted or compressed.

This paper is intended solely as a study in taxonomy, detailed figures of mouth parts are therefore not given. It is probably true that taxonomic characters may be found in them but without having a number of species within the same genus for comparison it would be difficult to determine upon what part the intensive study should be placed. This is particularly true in genera like *Stratiomyia* and *Odontomyia* each of which contains a number of species. Students interested in a study of the homologies of the mouth parts are referred to the most excellent paper of Prof. J. C. H. de Meijere (1916) as well as to the earlier work of F. Brauer (1883).

An interesting feature brought out in this study is the fact that in a number of details of structure, armature of body, and mouth parts, the earlier instars differ from the final one. In all larval stages the body bristles are for the most part spiculate and more or less flattened. In the European *Pachygaster atra*, and in the penultimate instar of *Microchrysa polita* they are also slightly clavate.

In the following key I have not indicated subfamily limits. Our knowledge of the early stages of this family is still too fragmentary to attempt broad generalizations. *Xylomyia* is here included. Whether this genus is to be referred to the Stratiomyiidæ or the Leptidæ is still an open question. When emerging, the imago of the members of this genus withdraws the pupal skin, at least in part, from the puparium, while in the Stratiomyiidæ the pupal skin remains wholly within it. Other characters of larvæ and adult also indicate Leptid affinities.

*A.* Last abdominal segment with a tuft of soft plumose or pubescent hairs; aquatic or semiaquatic species.

*B.* Caudal margin of the ventral side of at least the penultimate abdominal segment with a pair of stout, curved thorns or hooks; antennæ over three times as long as broad; body more or less striped.

*C.* Antennæ placed at the latero-anterior angles of the head; no stout spines in a transverse row on the venter of each abdominal segment. ..... **Odontomyia.**

*D.* Species 20–30 mm. long; with a wide, paler, compound dorsal vitta made up of four pale and three brownish stripes; lateral margins dark; antennæ distinctly curved ..... **cincta.**

*DD.* Species 16 mm. long or less.

*E.* A pair of hooks on ventral posterior margin of segment eleven only; tip of antenna produced almost as far cephalad as the beak. ..... **Sp. A.**

*EE.* Hooks on venter of both segments ten and eleven.

*F.* One pair of stout hooks on ten and eleven.

*G.* Length of full-grown larva over 15 mm. .. **pilimanus.**

*GG.* Length of full-grown larva 12–15 mm. **vertebrata.**

*FF.* One pair of stout hooks on 11, four or more on 10.

*G.* Four hooks on 10; antennæ about four times as long as broad, tips produced beyond tip of beak .... **virgo.**

*GG.* Four hooks on 8, six on 9 and 10, and two on 11; antennæ stouter, not produced to tip of beak... **Sp. B.**

*CC.* Antennæ placed dorsally, remote from the margin; each abdominal segment except the last, before its middle on ventral side, with a transverse row of short, stout spines ..... **Euparyphus.**

*D.* Ventral hooks of penultimate segment large, over half as long as the segment itself; the last instar with anterior spiracles on elongate processes (figs. 5, 6, 7, 13, 15); length 9 mm. **brevicornis**

*DD.* Ventral hooks of penultimate segment much shorter.

*E.* Ventral hooks distinctly longer than the five straight, stout spines on the same segment; median process (beak) of the head not produced as far cephalad as the mouth parts (figs. 1, 4, 12); length 13 mm. ..... **greylockensis.**

*EE.* Ventral hooks but little if any longer than the two straight, stout spines before the middle of the same segment (figs. 2, 3); length 10 mm. ..... **tetraspilus.**

*BB.* No ventral hooks on the penultimate segment.

*C.* Posterior spiracular chamber on the dorsal side of the terminal segment, this segment emarginate and armed with four to six long marginal setæ; fringe of plumose hairs short, not, or scarcely produced beyond the markin of the segment (fig. 18). .. **Nemotelus.**

*CC.* Posterior spiracular chamber at the apex of the segment; hair fringe long.

*D.* Terminal abdominal segment not much longer than broad (fig. 21). ..... **Oxycera.**

*DD.* Terminal abdominal segment much longer than broad..... **Stratiomyia.**

*E.* Terminal segment about five times as long as its width at base (fig. 9). ..... ..... **norma.**

*EE.* Terminal segment not over three times as long as its width at base.

*F.* Penultimate abdominal segment about three fourths as long as the terminal segment. ..... **normula.**

*FF.* Penultimate segment about five eighths as long as the terminal segment. ..... ..... **meigenii.**

*FFF.* Apical half of last abdominal segment cylindrical, instead of conical as in *normula* and *meigenii;* penultimate segment about .7 as long as the last. ..... **discalis.**

*AA.* Last abdominal segment without a tuft of plumose hairs; species living in dung, decaying vegetable matter, decaying wood, or bark or refuse.

*B.* Each segment laterally with two lobes, the anterior one much narrower (figs. 40, 41); length 8.5 mm. In the penultimate instar the head is more tapering and the mouth parts simpler. .. **Allognosta fuscitarsis.**

*BB.* Lateral margin not so lobed.

*C.* Antennæ located on disc of head well back from the margin.

*D.* Outer bristle of each dorsal transverse series of abdominal segments not more than one sixth as long as the next bristle; innermost bristle also short (figs. 19, 20). .. **Eupachygaster henshawi.**

*DD.* Bristles very long, in transverse series, not so strikingly different in length (fig. 10). .....**Zabrachia polita.**

*CC.* Antennæ located at or near the margin of the head.

*D.* Antenna over three times longer than wide; yellowish species, incisures distinctly blackish, each segment marked with a small spot on each side and a larger median spot, the latter on the intermediate segments with clear space in the center; bristles very short; length of larva 8 mm. Not reared. (*Beris* or *Actina?*) ..... **Stratiomyiid I.**[1]

*DD.* Antennæ short, last segment about as long as wide.

*E.* "Eye" tubercles prominent, body more or less distinctly longitudinally striped; without numerous appressed scale-like hairs.

*F.* Head broadest at base, tapering anteriorly, two more or less prominent tubercles on each side of head (figs. 27, 30); length 10 mm. ..... **Macrosargus clavis.**

*FF.* Head at least as broad at the tubercles as at the base.

*G.* Width of head about two thirds that of its length; terminal abdominal segment with a distinct cleft, a short bristle on each apex (figs. 22, 24); length 8 mm.; penultimate instar with slightly clavate body bristles (fig. 23). ..... **Microchrysa polita.**

*GG.* Head nearly or quite as wide as long. **Geosargus.**

*H.* Dorsum of body with two distinct longitudinal, pale, more or less zigzag stripes and pale lateral margins; head slightly longer than wide; anterior angle of eye tubercle not distinctly reëntrant (figs. 25, 33); length 10 mm. ..... **decorus.**

*HH.* Body with six distinct longitudinal, dark, zigzag stripes; head about as long as broad; anterior angle of eye tubercle reëntrant (figs. 26, 34); length 10 mm. ..... **viridis.**

[1] See notes below, under Beridiinæ.

*HHH.* Body usually with two indistinct, pale, irregular, longitudinal stripes, head slightly wider than long; anterior angle of eye tubercle strongly reentrant (fig. 29); length 9 mm. ..... **cuprarius.**

*EE.* Eye tubercle not prominent except in *Hermetia;* body covered with more or less appressed scale-like hairs, except in *Neopachygaster* (fig. 8).

*F.* Body bristles slightly clavate; terminal abdominal segment slightly cleft; body usually striped, sometimes but faintly. Penultimate instar (fig. 23). **Microchrysa polita.**

*FF.* Not as above.

*G.* Head with stellate hairs (fig. 32). Penultimate instar. **Geosargus A.**

*GG.* Head without stellate hairs.

*H.* Head only slightly longer than broad; antennæ situated distinctly proximad of the latero-anterior angle of the head. Penultimate instar. (fig. 35). **Geosargus B.**

*HH.* Head noticeably longer than broad.

*I.* Eye tubercles distinct; antennæ situated distinctly proximad of the latero-anterior angles of the head; posterior margin of last abdominal segment slightly emarginate (figs. 38, 39). **Hermetia illucens.**

*II.* Eye tubercles less distinct.

*J.* Antennæ situated at the apex of the latero-anterior angles of the head (penultimate instar of *Hermetia?* Fig. 36). **Stratiomyiid II.**

*JJ.* Antennæ situated proximad of the latero-anterior angles of the head.

*K.* Body with more or less appressed scale-like hairs and short bristles; head bristles short (fig. 31). Penultimate instar. **Macrosargus clavis.**

*KK.* Body without appressed scale-like hairs, bristles stout, almost clavate (fig. 8a); the longer head bristles half as long as the diameter of the head. **Neopachygaster maculicornis.**

*KKK.* Body without appressed scale-like hairs; differs from the foregoing in having on the disc of segments one and two a large transverse chitin plate instead of numerous small oval plates. .. **Xylomyia pallipes.**

## Pachygasterinæ.

The genus *Pachygaster* in its narrowest sense includes one North American species, *P. pulcher* Loew, which, though not common, appears to have a wide distribution. But little is known of its habits. The early stages of the European *P. atra* Meigen, the type of the genus, has been described by Heeger, and others. It has clavate body bristles like the penultimate instar of *Microchrysa polita* but lacks the cleft at the apex of the abdomen (fig. 16). Verrall states that the larvæ are found in rotten detritus of the elm. According to Heeger the larva hibernates under leaves and stones, the adults appearing in April in Central Europe. The eggs, six to ten in number, are laid in moist places on the earth, and hatch in eight to twelve days. The larva feeds on dead animal matter found in the mud, but may also feed on living earthworms and maggots. When full grown it is about 6 mm. in length. In from one to three months the adults appear, and may be found from April to September. It thus appears that there are two broods. The early stages of other European species are described by Lundbeck (1907), Verrall (1909) and others.

The larva of *Zabrachia polita* Coq. was found by Mr. C. W. Johnson (1906) under the wet, decayed bark of pine logs. It is 5 mm. long and brownish in color (fig. 10). The adults appear in May and June. Bezzi has referred the European *Pachygaster minutissima* Zett. (fig. 14) to the genus *Zabrachia*. The larva of this species which is found under the decaying bark of conifers is described and figured by de Meijere (1916) and Trägaardh (1914), as well as by earlier authors.

A specimen of *Zabrachia polita* was kindly lent me by Mr. C. W. Johnson for study. The head resembles that shown in figure 14 but the mouth parts are folded down so that they do not project forward. The line of articulation of these parts makes a distinctly acute angle with the longitudinal axis instead of being nearly a right angle and the bristles are also more numerous, some almost clavate. The antennæ are placed about as shown in the figure of *Z. minutissima* (fig. 14). Figure 10 is a ventral view of *Z. polita*. The dorsal bristles are longer and stronger than the ventral. On the first segment there are two transverse ranges but on each of the succeeding

segments but one, each with six long and strong bristles besides the still longer laterals.

The larva of *maculicornis* Hine, the North American representative of the genus *Neopachygaster* was described by Greene (1917) and also by Malloch (1917). Greene found larvæ in the early spring under the bark of the tulip tree. Malloch's specimens were obtained under the bark of fallen elm trees, where they were feeding on the decaying matter under the slightly loosened bark. They appear also to be carnivorous. The larva resembles the penultimate instar of *Microchrysa polita* but differs in lacking the appressed scale-like hairs, the cleft terminal segment of the abdomen, and in having the body bristles less distinctly clavate. My specimen was received through the kindness of Mr. Greene.

The larva of *Eupachygaster henshawi* Malloch was found by Malloch (1917) under the loose bark of an apple tree, feeding upon sap and upon insect larvæ.

The early stages of *Berkshiria albistylum* John. and *Johnsonomyia aldrichi* Malloch are as yet unknown.

## Clitellariinæ.

The genus *Euparyphus* is represented in eastern United States by several species, three of which I have reared. The larvæ of *E. brevicornis* were found in algæ and moss which grew on the sides of the rocks that bordered a brook, and were continually wetted by the running water. Some were also found in moss over which there was a trickling stream of water. Larvæ in all stages were found in May and June. Figures 5, 6, 7, 13 and 15 show the penultimate and last instars. In the first instar the curved thorns, so conspicuous in larger larvæ, are wanting, although their basal protuberances are in evidence.

The larvæ of *E. greylockensis* and *E. tetraspilus* were found in the water in overhanging vegetation growing on the margin of a brook. The former was collected in June, the latter in July. My bred specimen of *E. greylockensis* differs from the description of the type in having small lateral stripes on the fourth abdominal segment. It may deserve a varietal name.

I believe that the European *Oxycera tenuicornis* Macq. should be

placed in the genus *Euparyphus*. It is also quite possible that the unreared larva described by Haliday (1857) and doubtfully identified as *Oxycera morrisii* belongs to *tenuicornis* instead.

Though the genus *Nemotelus* occurs in the eastern states, the larvæ of our species have not been described. Figure 18 represents the larva of the European *N. pantherinus*, which, according to Lundbeck, lives in water among plants. It hibernates as a larva and transforms the following spring or summer. Haliday (1857) states that the larvæ of *N. uliginosus* are common under dried-up algæ and other vegetable matter strewn on the ground especially in marshy spots on the shore. In all probability, however, it is only at time of pupation that they tolerate a dry situation.

Neither have the early stages of the North American representatives of the genus *Oxycera* been described. Heeger (1856) figured and described the larvæ of two European species *O. Meigenii* and *O. trilineata*. The larvæ of *O. Meigenii* live in small brooks concealed in the ooze, coming to the surface in warm weather. In captivity they feed readily on roots of plants, bread crumbs, and dead earthworms. In the spring they creep into dry situations under stones and the like, to pupate. The full-grown larva measures 12 to 14 mm. in length. The flies emerge in July, laying their eggs soon after. The oval eggs measure 0.5 x 1.5 mm. Heeger's figure of *O. trilineata* is reproduced in figure 21. The larva of this species when full grown measures about 10 mm. in length. In habits it resembles the foregoing. Lundbeck, who also describes it, states that the larva lives in mud, and that the development of the imago takes place in spring or summer. The life histories of the other species of this subfamily represented in the fauna under consideration are unknown. These are *Akronia frontosa* Hine, recorded from Ohio, *Clitellaria subulata* Loew from Virginia, and *Scoliopelta luteipes* Will. from New Hampshire.

Since the foregoing paragraphs were written I have seen a specimen of each of the genera Nemotelus and Oxycera, both taken from frog stomachs. These species differ only in specific characters from the European forms given in the keys. My specimen of *Nemotelus* has the posterior margin of the last abdominal segment slightly emarginate instead of notched.

## Stratiomyiinæ.

The larvæ of several species of each of the genera *Stratiomyia* and *Odontomyia* have been described. Some of the European species have long been known. Lundbeck gives a key to several European species, while Hart (1895) and Malloch (1917) have dealt with the biology of several native forms. Of the species of these two genera mentioned in the foregoing keys I have not seen *O. vertebrata,* but have inserted it on the basis of Hart's description. It is quite probable that better diagnostic specific characters may be found than those which I have used. The poor condition and limited number of specimens of some of the species prevented my making use of minor characters which might prove important. The number of hooks on the venter may, indeed, not even be of specific value. The adult of the species which I have called Sp. B in the key very closely resembles the female of *O. virgo.* My reared specimen of *O. pilimanus* is a male; it differs from a typical specimen in having longer thoracic pile and a broader abdominal stripe.

All the specimens of both genera were collected in ponds or on their margins where the insects go to pupate. When about to pupate, or after pupation, they withstand drying out to a remarkable degree. Their food consists of decaying vegetable matter (or possibly the fungi growing in this), of algæ and other small microorganisms.

The immature stages of *Nothomyia viridis* Hine are not known.

## Sarginæ.

The genus *Geosargus* is represented by four or five species in the Eastern States. A series of experiments by Dr. J. G. Needham, conducted for the purpose of producing an economical fish food, involved the cutting up of a quantity of the stems of succulent plants and other vegetable matter This material became infested with the larvæ of a number of insects among which was *Geosargus decorus,* adults emerging in August. I have also found this species, as well as *G. cuprarius,* in cow dung. The latter species was also bred by Prof. Britton (1915) of Connecticut from larvæ found on the earth, near strawberry crowns. In Europe it was bred by Westwood from garden mold, by Beling from decomposing heaps of

rotting weeds, by Bremi from cow dung, while Dufour states that he obtained it from ulcers in elms. My larval specimens of *Geosargus viridis* were found by the late Prof. M. V. Slingerland living in the richly fertilized soil of a potted green house plant. The specimens described by Malloch were obtained from cow dung.

Some larvæ found in cow dung, but not reared, when placed in caustic potash and later examined showed plainly through the integument the next succeeding instar. By careful manipulation it was possible to draw out the inner skin which proved to be quite similar to that of *G. viridis* making allowance for future expansion. The penultimate instar thus differs strikingly from the final instar, the depressed scale-like hairs being characteristic. The heads of these are shown in figures 32 and 37. This form is designated as Sp. A in the key.

Some larvæ closely resembling the foregoing but differing in the form and armature of the head (fig. 35) were found associated with the *G. decorus* larvæ in Dr. Needham's experiment. Their form, and body covering of depressed hairs indicate that they are the penultimate instars of *Geosargus*, and probably of *G. decorus*.

Figures 27 and 30 are details of the larva of *Macrosargus clavis* Will., while fig. 31 shows the head of its penultimate instar. Dr. P. W. Claassen discovered these larvæ living in the frass of the larva of *Arzama obliqua* which infests cattail stems. The earlier stage was found in July, the last instar in April and May, of the following year, adults appearing in May and June. There appears to be but one brood which hibernates as larvæ in the last instar. The penultimate instar has body markings similar to, but feebler than, the last instar; the latter lacks the appressed scale-like hairs which the former possesses.

The last two instars as well as bred specimens of the adult flies of *Microchrysa polita* were obtained in July by Dr. Needham from the vegetable matter used in the experiments above mentioned. I have also reared this species from cow dung. The form described by Malloch as "Genus *Incertus* 3" is without much doubt the penultimate instar of *M. polita*. This instar is usually marked in a similar manner to that of the last instar, though sometimes the pattern is but feebly indicated. European writers record the rearing of this species from cow dung and decaying vegetable matter.

The immature stages of *Ptecticus* and of *Chrysochroma nigricorne* are as yet unknown.

## Hermetiinæ.

This subfamily is not recognized by Williston in his Manual. *Hermetia* being placed in the Clitellarinæ, while *Acrochæta* and related genera are placed with the Sarginæ. I prefer the arrangement given by Kertesz in his Catalogus Dipterorum, as being the more natural.

Though *Hermetia illucens* has a southern range, it has been recorded as far north as New Jersey, and is therefore included in this paper. One of my specimens together with its puparium was given to me by Mr. L. H. Dunn, he having obtained the specimens from human carrion in Panama. The larvæ are said to be abundant in decaying vegetables and not uncommon in silos throughout the south. Malloch states that they are numerous in latrines.

Specimens of what I believe to be the penultimate instar were collected by Dr. J. C. Bradley in Georgia from a pile of decaying paper and other organic matter (fig. 36).

## Beridiinæ.

The only larvæ of members of this subfamily which I have seen belong to the species *Allognosta fuscitarsis* Say. They were found in decaying organic matter associated with *Fannia scalaris.* The larva is more slender than the puparium (fig. 41). The penultimate instar differs in having a more tapering head and has numerous appressed scale-like hairs upon its body. Malloch's Genus *Incertus* 1 is probably the penultimate instar of this, or another species of the same genus.

The early stages of *Beris annulifera* and *morrisii,* and *Actina viridis* have not yet been described. The larva of the European *Beris vallata* Foerst. has been described by de Meijere (1916) who found it among decaying leaves. The characteristic feature of this form is the arrangement of the minute setæ in small tufts upon the abdominal segments (fig. 28). *Actina viridis* is an anomalous form, the male having dichoptic eyes as in the genus *Actina,* but its wing venation is typically that of *Beris.* Handlirsch (1883) has described and

figured the puparium of *Chlorisops* (*Actina*) *tibialis* Meigen, an European species (fig. 17). The larvæ were found in the woods in leaf mold.

## Xylomyiinæ.

*Xylomyia pallipes* is the only member of this subfamily of which I have seen larvæ. When placed in weak hydrochloric acid effervescence takes place as with the true Stratiomyiidæ. My specimens were obtained from under loosened bark.

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### EXPLANATION OF PLATES.

#### PLATE IX.

The figures are of the last instar larvæ unless otherwise stated.

FIG. 1. *Euparyphus greylockensis* John. Dorsum.

FIG. 2. *Euparyphus tetraspilus* Loew. Dorsum of seventh body segment.

FIG. 3. *Euparyphus tetraspilus* Loew. Venter of apical abdominal segments.

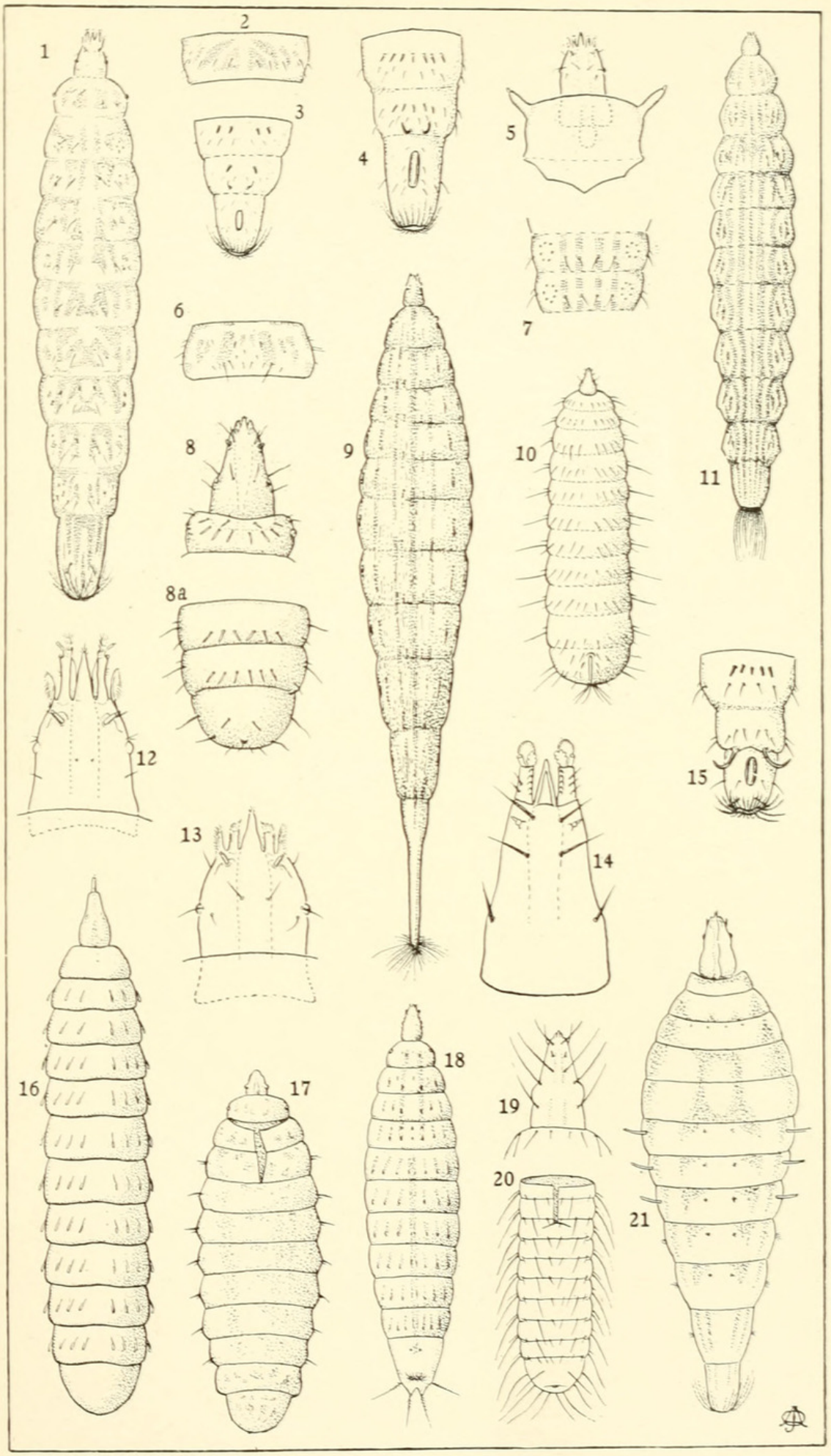
FIG. 4. *Euparyphus greylockensis* John. Venter of apical abdominal segments.

FIG. 5. *Euparyphus brevicornis* Loew. Dorsum of head and prothorax of puparium.

FIG. 6. *Euparyphus brevicornis* Loew. Dorsum of seventh body segment.

FIG. 7. *Euparyphus brevicornis* Loew. Dorsum of eighth and ninth body segments of penultimate instar.

FIGS. 8, 8a. *Neopachygaster maculicornis* Hine. Dorsum.




STRATIOMYIIDAE.